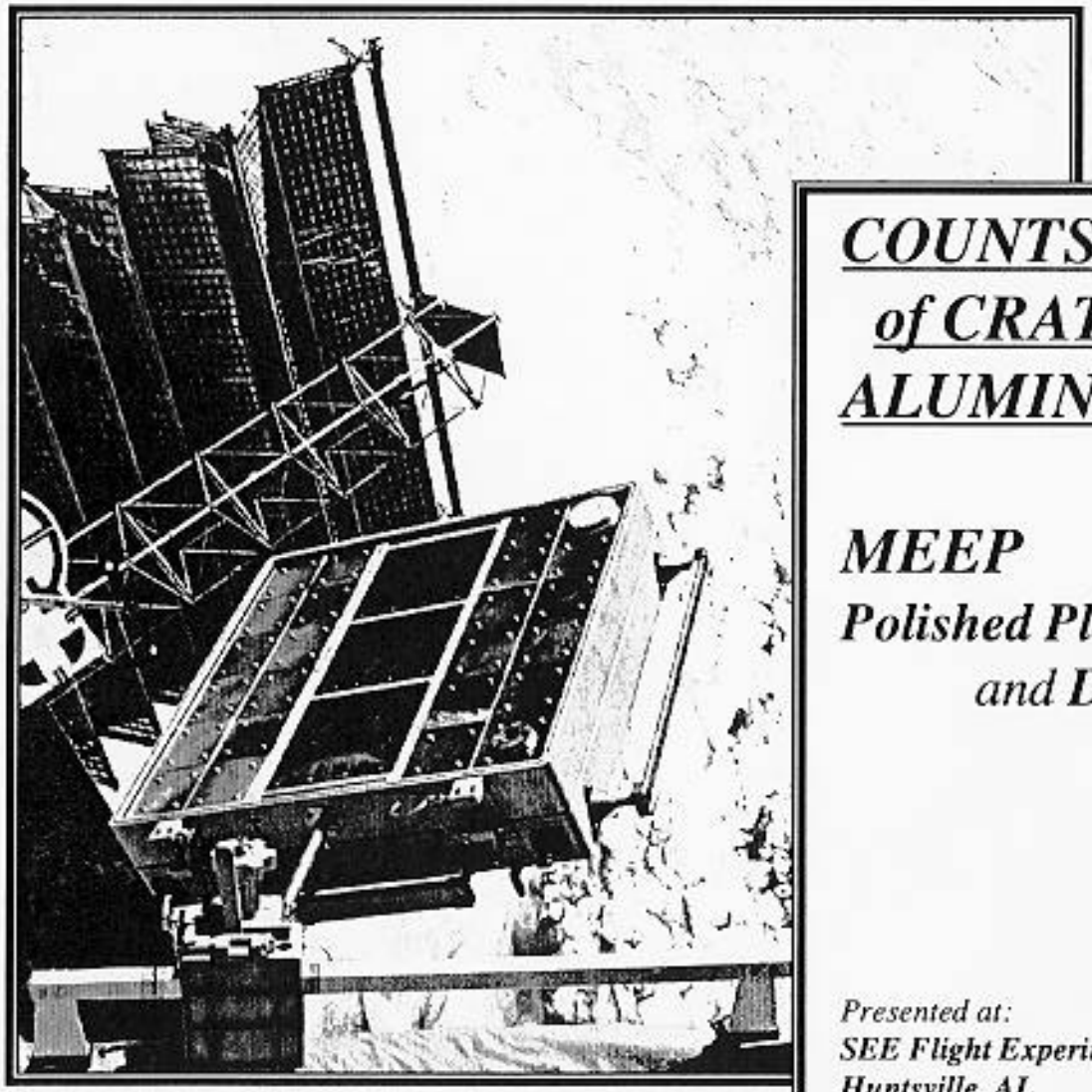
Overview of SEE Program
M&D Flight Experiments having LaRC Involvement

- ***MEEP PPMD Experiment***
- ***STRV-2 M&D Experiment***
- ***ESEM M&D Collection Experiment***
- ***MIGHTYSAT M&D Experiment***
- ***SUNSAT M&D Experiment***
- ***APEX Debris Experiment***

Presented at -
SEE Flight Experiment Work Shop
June 23 - 25, 1998

By -
William H. Kinard
NASA - Langley Research Center

MEEP PPMD Experiment



COUNTS & ANALYSIS of CRATER in PPMD ALUMINUM TARGETS

MEEP
Polished Plate Meteoroid and Debris Experiment

by
Donald H. Humes
William H. Kinard
James L. Jones, Jr.
NASA, LaRC

Presented at:
SEE Flight Experiments Workshop
Huntsville, AL
June 23-25, 1998

OBJECTIVES of PPMD EXPERIMENT

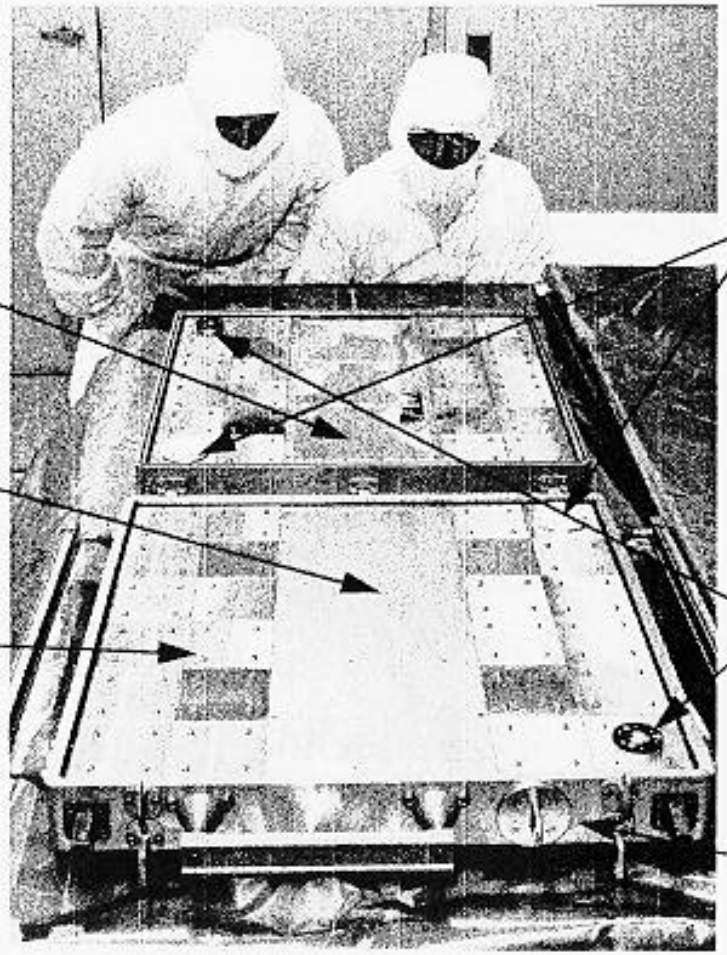
- *Establish the impact fluxes of small mass orbiting man-made debris and natural meteoroids on Mir .*
- *Establish sources of the small mass orbiting man-made debris impacting Mir.*

Note :

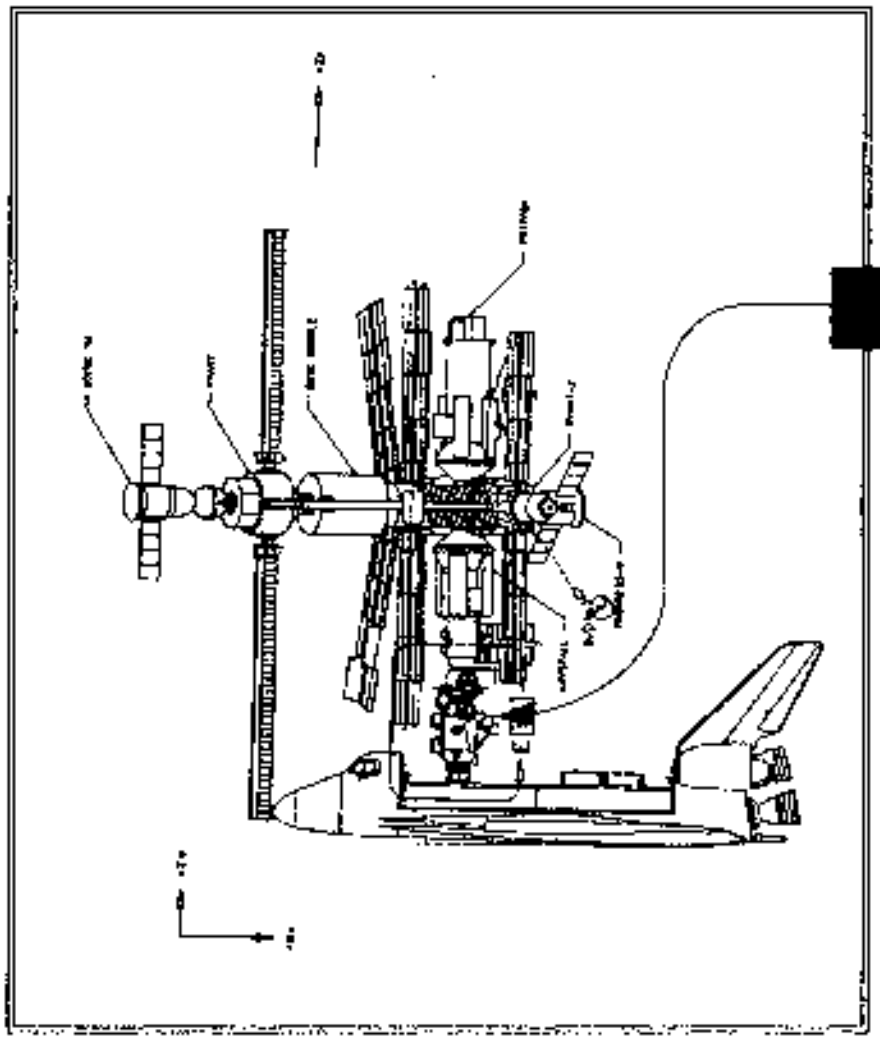
It is expected that the small mass debris and micrometeoroid impact fluxes measured on Mir will be representative of the impact fluxes to expect on ISS since both are large re-supplied spacecraft in low altitude high inclination orbits.

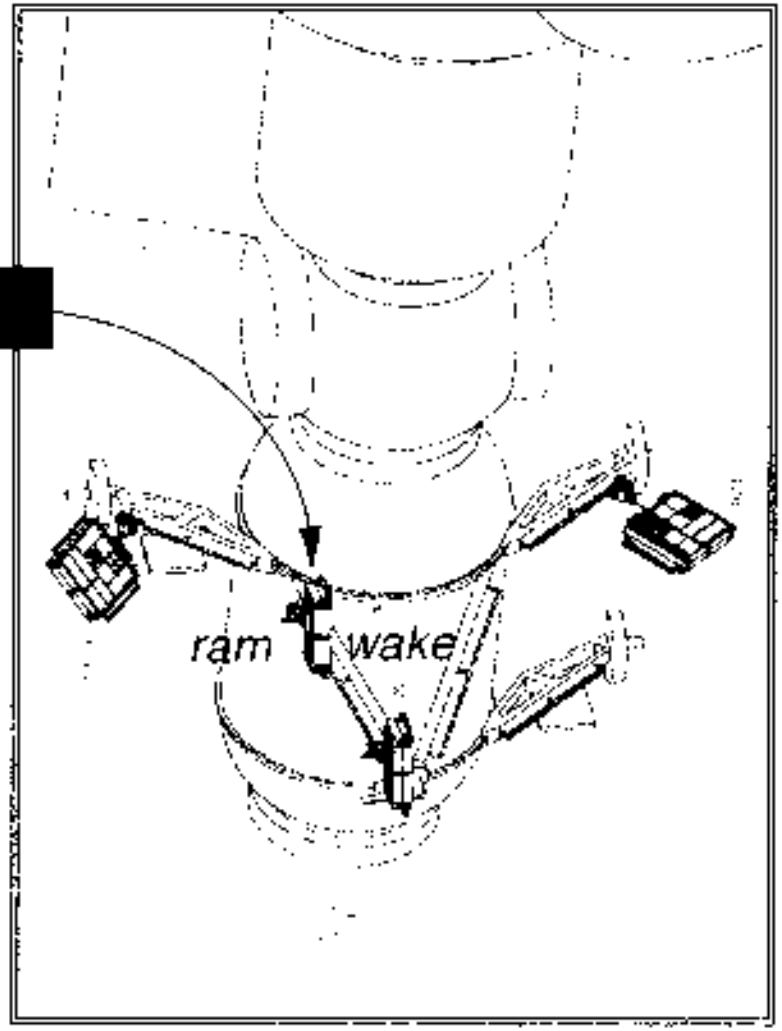
PPMD EXPERIMENT HARDWARE

- *Crater counts in the Aluminum (Al) plates have been completed and the impact fluxes presented are based on those counts.*

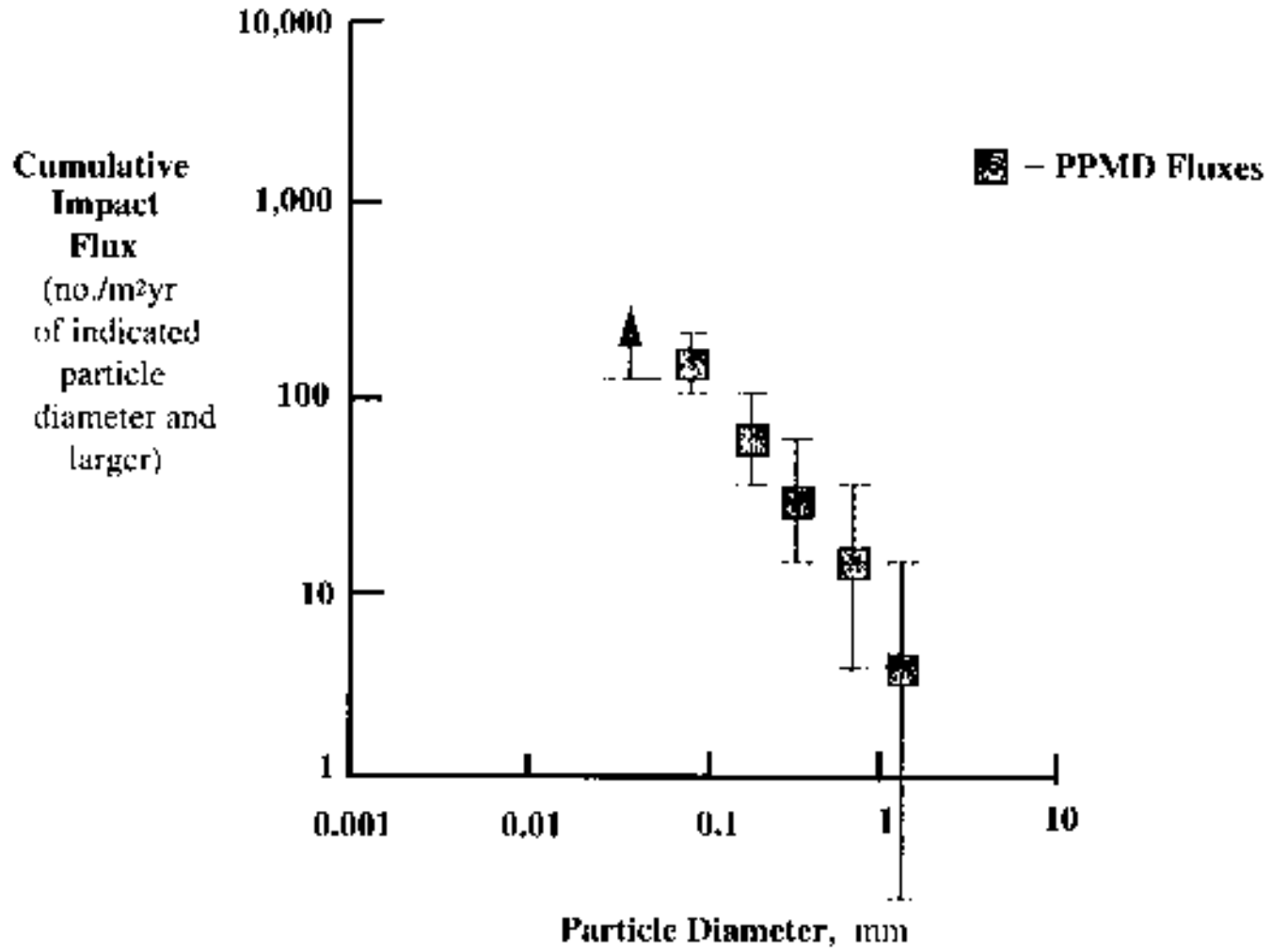


PPMD ORIENTATION ON MIR

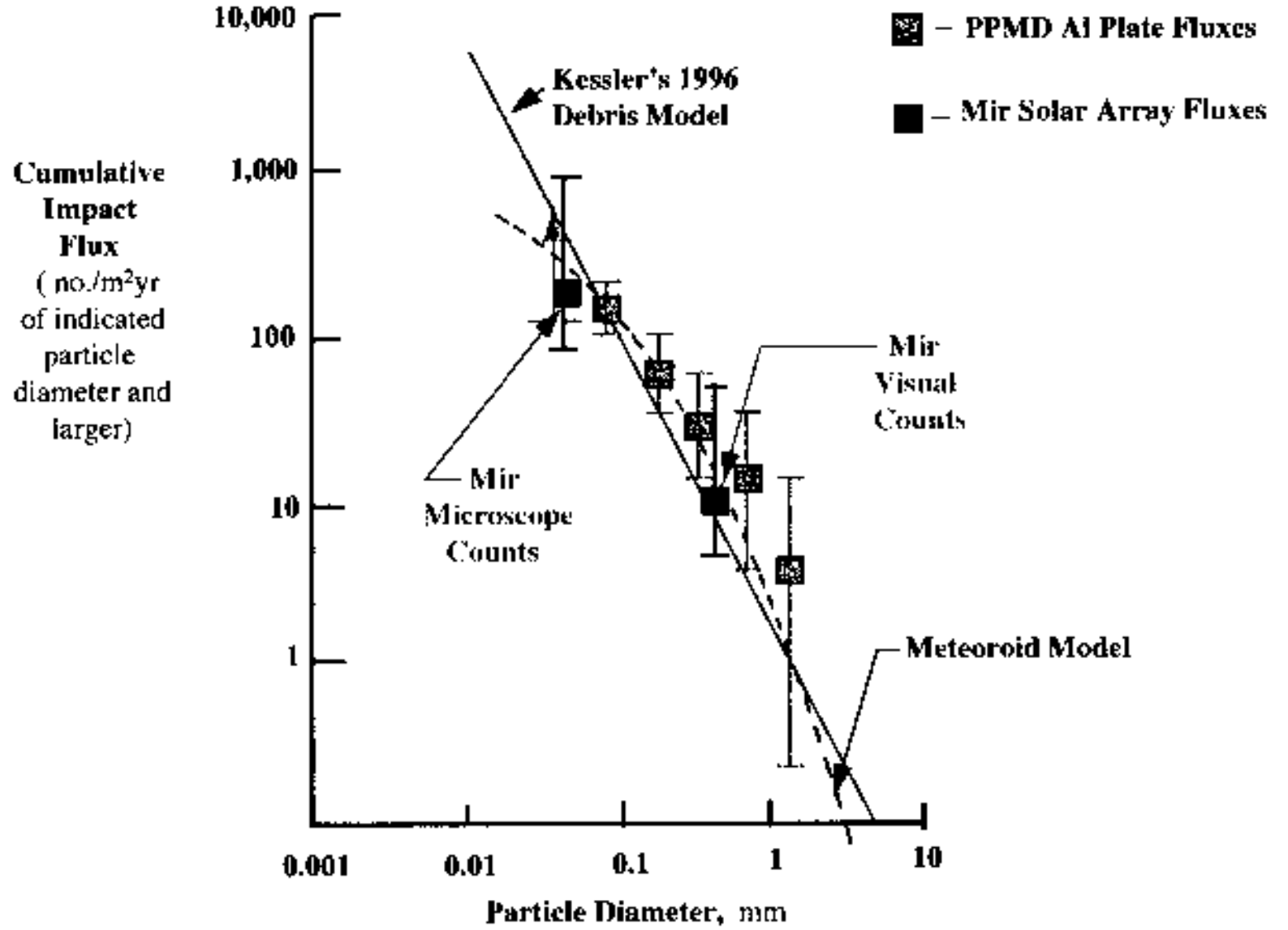




Impact Fluxes Indicated by PPMD Al Crater Counts



Impact Fluxes Indicated by PPMD & Mir Panel Crater Counts



Summary and Conclusions

- *The impact fluxes predicted by the current meteoroid and debris models fall within or close to the error bars of the impact fluxes calculated from the crater counts in the PPMD Al plates .*

- *The PPMD crater counts indicate that the fluxes for particles less than ~ 0.1 mm in diameter are less than the models predict.*

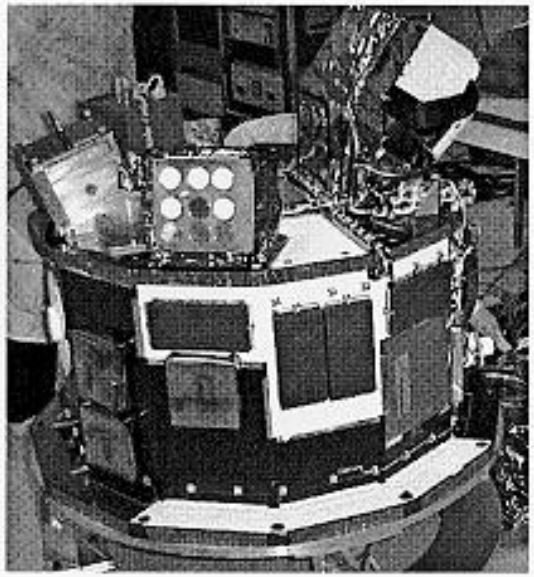
- *The PPMD crater counts also indicate that the fluxes for particles larger than ~ 1 mm may be greater than the models predict.*

STRV-2 M&D Experiment

STRV-2 Meteoroid & Debris Monitoring Experiment

- ***Principle Investigators :*** William H. Kinard, Donald H. Humes & James L. Jones, Jr.
  NASA-Langley Research Center, Hampton, VA

- ***Objective :*** Monitor small mass orbiting man-made debris and natural micrometeoroids as a function of altitude and time.

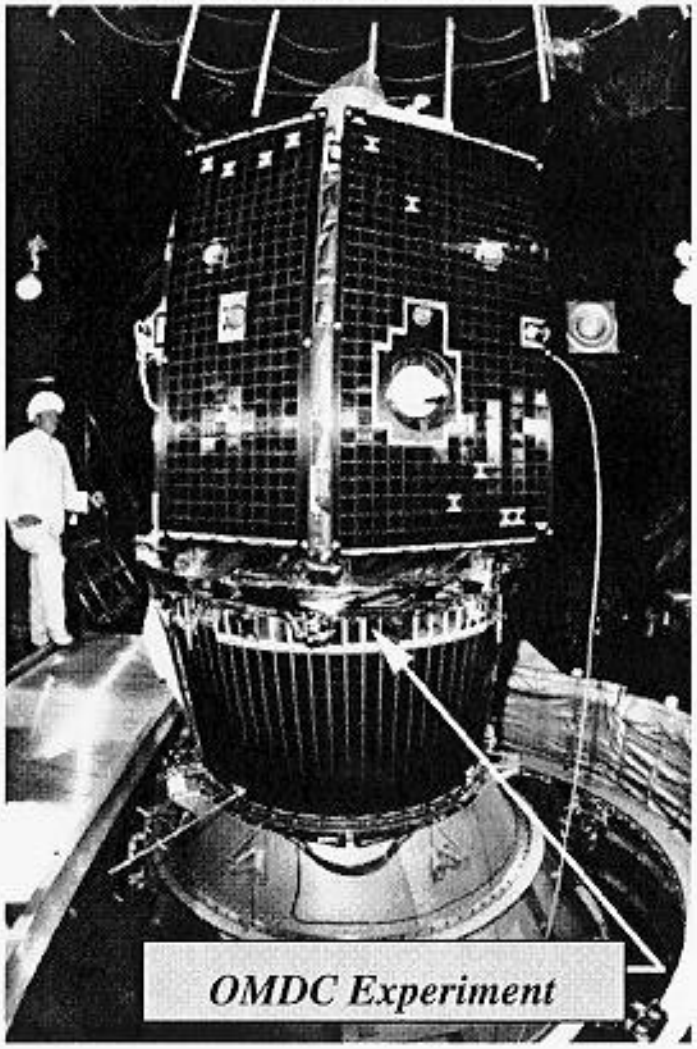


- ***Approach :*** Use Metal-Oxide-Silicon (MOS) capacitance type impact detectors.

- ***STRV-2 Orbit :***
  - Periapsis Altitude 460 km
  - Apoapsis Altitude 1800 km
  - Inclination 70 deg
  - Period 108 min

BACKGROUND

CLEMENTINE SPACECRAFT

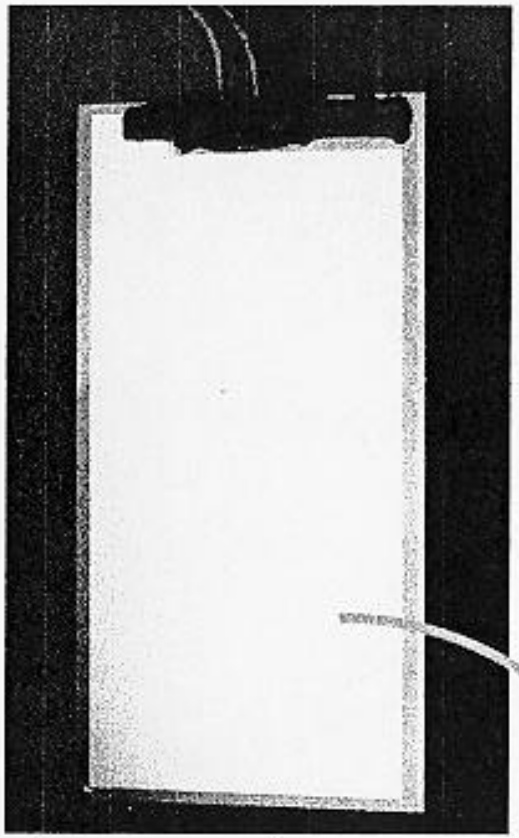


A similar meteoroid & debris experiment was flown on the Clementine Interstage Adapter Satellite (ISA), however, a launch trajectory error caused the ISA to re-enter after only 3 months in orbit- 20% of the planned orbital lifetime.

The short orbital life and also the inability to get adequate spacecraft orientation information reduced the usefulness of the data returned from the Clementine OMDC Experiment.

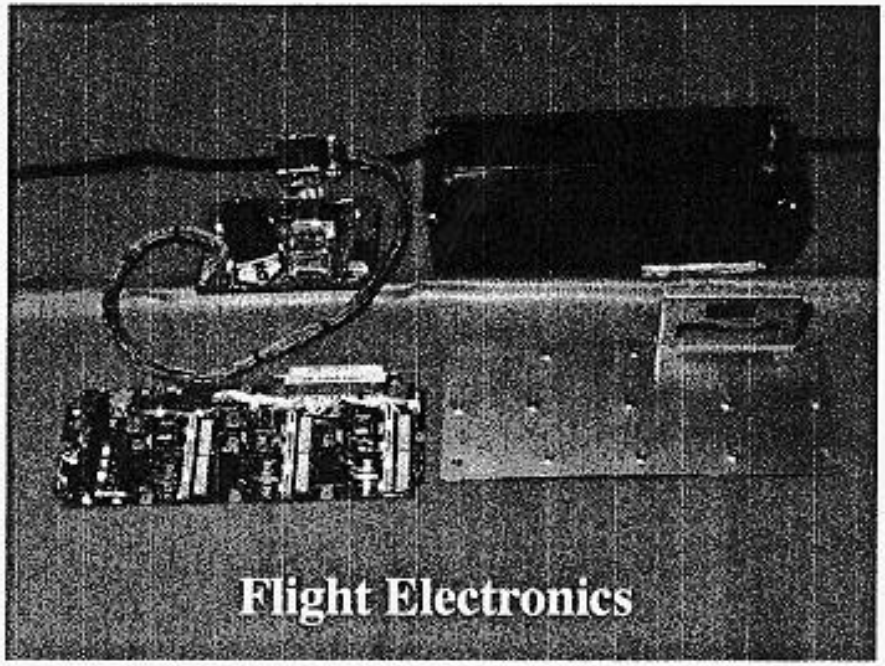
The STRV-2 Meteoroid and Debris Monitoring Experiment is using the back-up flight hardware from the OMDC Experiment.

STRV-2 M&D Experiment Components

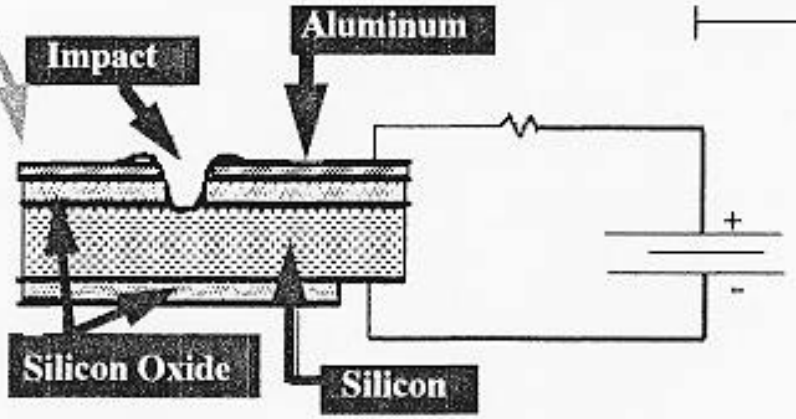


1 in.

MOS Detector



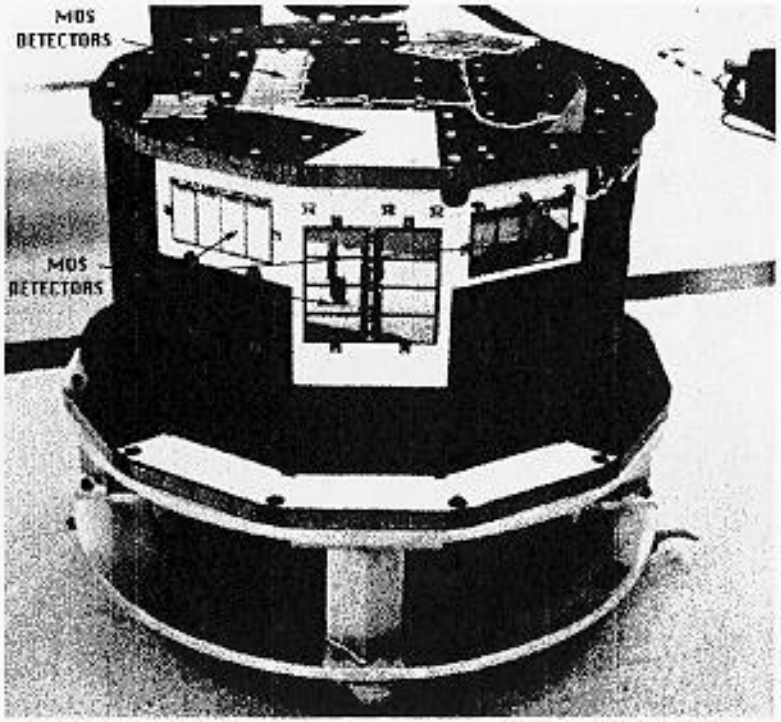
6 in.

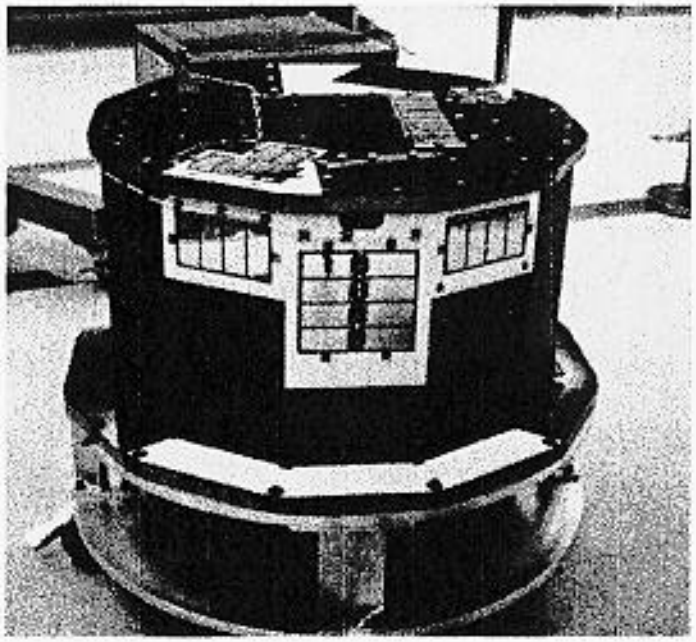


Schematic of Detector System

Detectors Mounted on STRV-2 Structure

Top & Front Sides





Top & Rear Sides

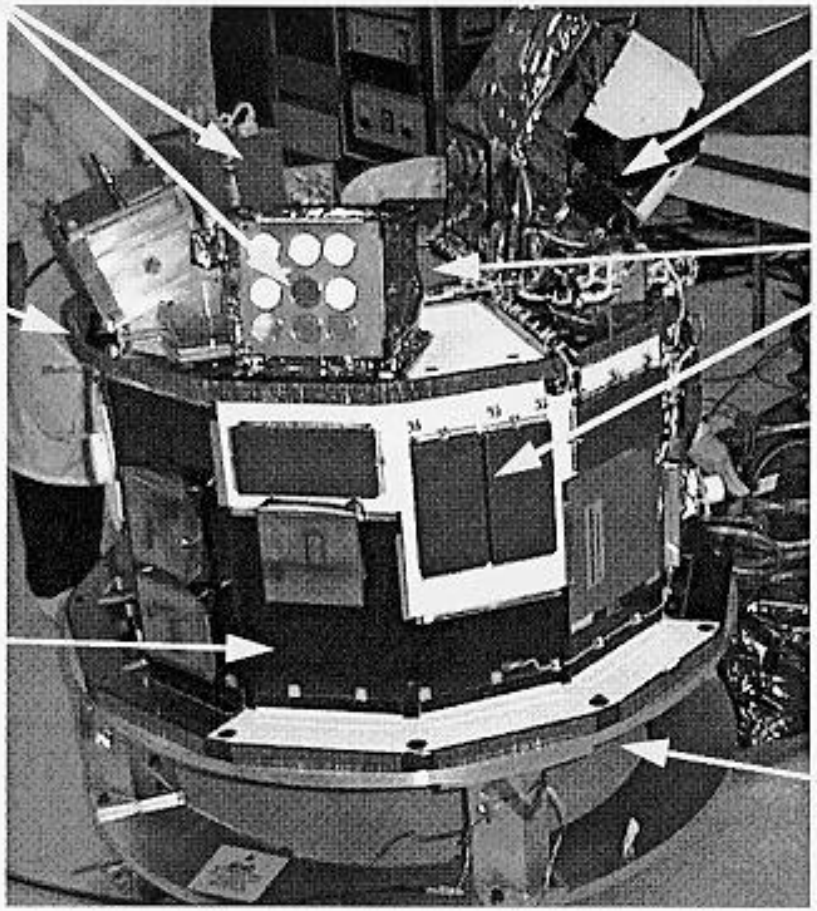
Assembled STRV-2 Spacecraft

Joint NASA / DOD Mission

Sammes II Test Modules

LASERCOMM (laser communication

ACESS (all composite experiment spacecraft structure)



MOS Detectors (prelaunch protective covers in place)

VISS (vibration isolation suppression steering system) (mounted internally)

UK MWIR (medium waveband IR) **Telescope** (mounted on bottom)

- Launch planned in December 1998.
- Data will be placed on Internet as received.

STRV-2 Meteoroid & Debris Monitoring Experiment

- *Launch - Scheduled for December 1998*
- *Lifetime - Multiple years expected*
- *Measurements to be made -*

  a) time of impact events on detectors,

  b) location on spacecraft of detector impacted in each event,

  c) Orientation of spacecraft at time of each impact event,

  d) orbital position of spacecraft at time of each impact event,

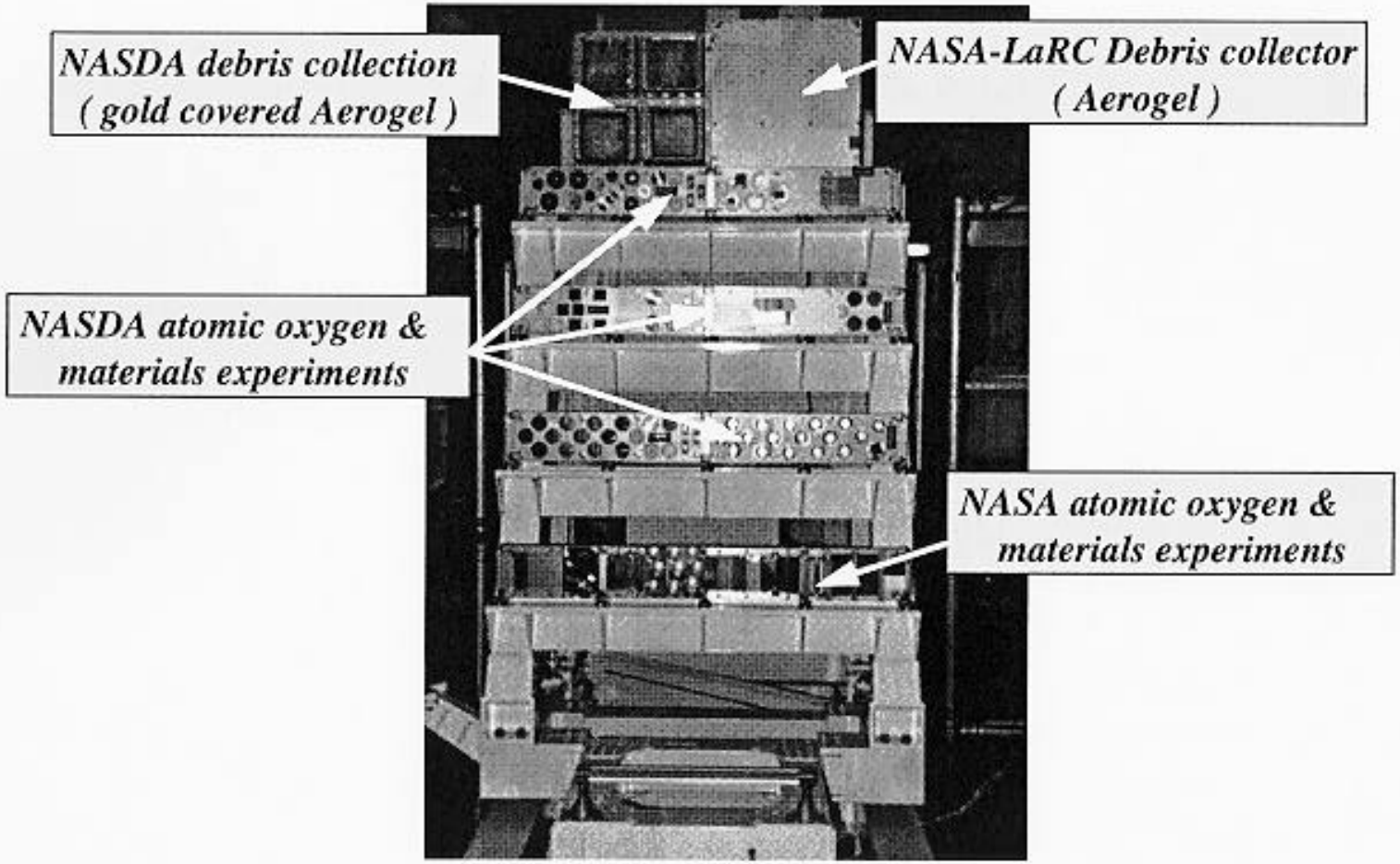
  e) health of each detector.

ESEM M&D Collection Experiment

NASDA/NASA - ESEM Experiments

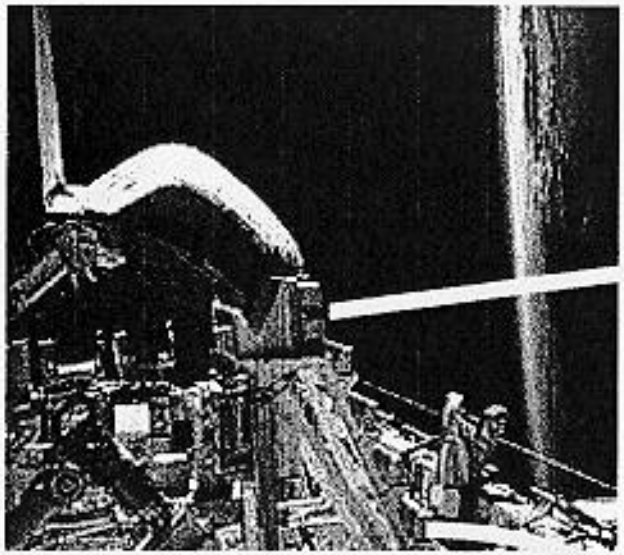
- *Joint NASDA & NASA investigations of A.O. effects on materials and the cosmic dust and man-made debris environments in LEO. Also a 1st step by NASDA in learning how to perform exposure experiments with the JEM Exposure Pallet on the ISS.*

ESEM EXPERIMENT RACK

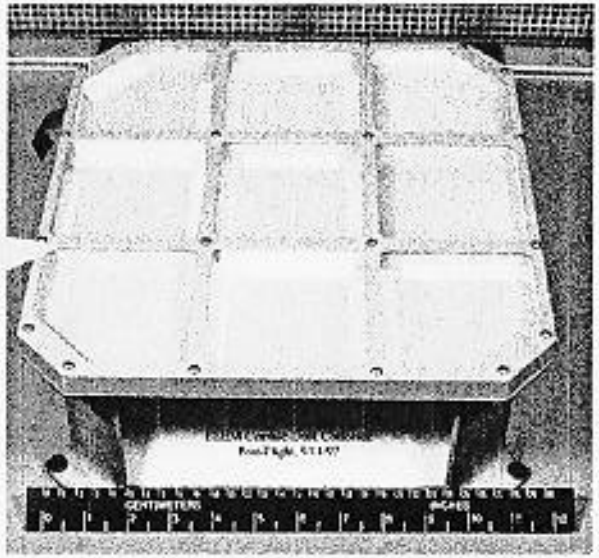


NASA - ESEM Experiments

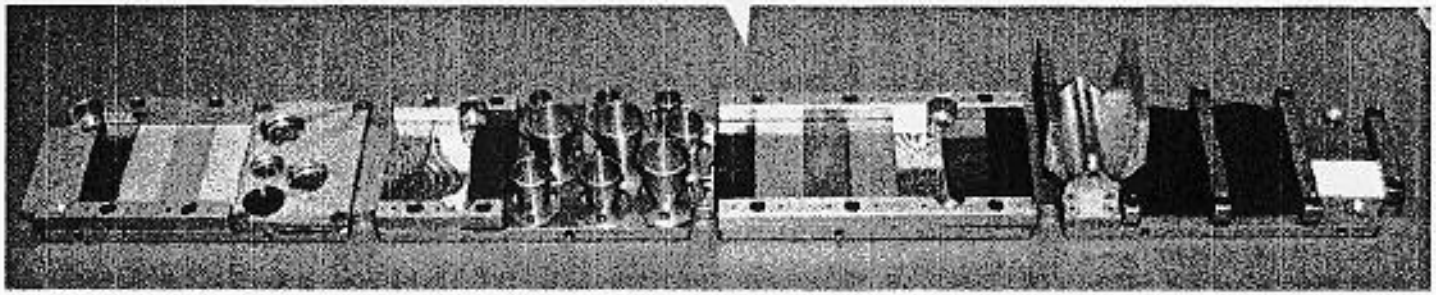
Flown on STS-85 Mission:



ESEM experiments on rack in orbiter cargo bay



ESEM debris collection experiment post flight (Aerogel)

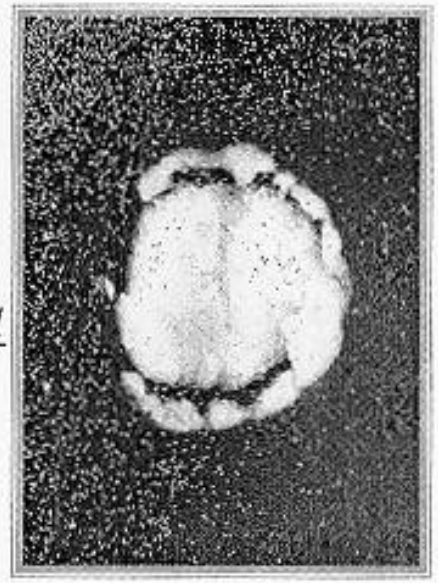


ESEM atomic oxygen experiment post flight

NASA - ESEM Debris Collection Experiment

- *No debris impact tracks or captured particles were found in visual scans of the Aerogel blocks. (NASDA also found none in their Aerogel blocks)*
- *Numerous hemispherical craters were found on the Aerogel exposed surfaces.*

Typical Hemispherical Crater



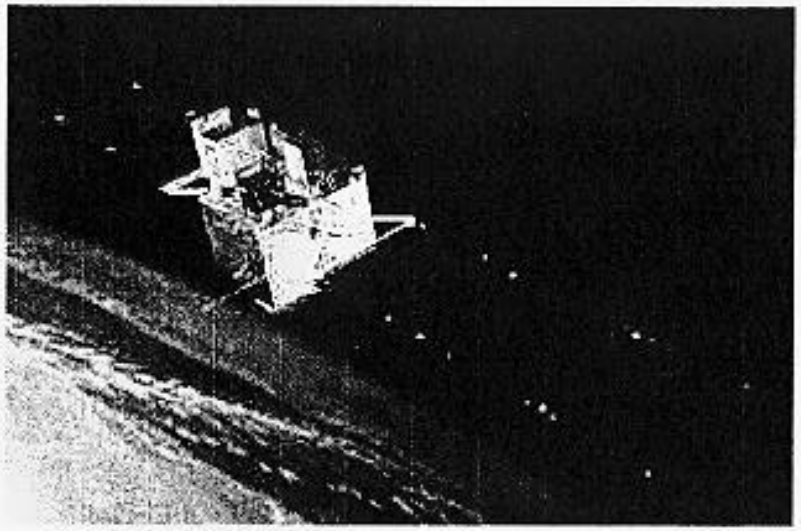
These craters may have resulted from impacts of drops of liquid contaminants on the Aerogel surface while exposed in space. They also could have resulted from impacts of very fast particles.

- *Microscopic scans of the Aerogel blocks and the surrounding aluminum frames are on-going.*
- *Chemical studies of identified features will be performed later this year.*

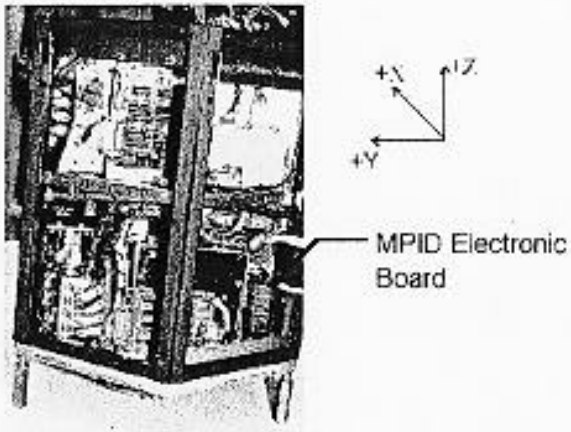
MIGHTYSAT M&D Experiment

MIGHTYSAT - Air Force Research Lab Spacecraft

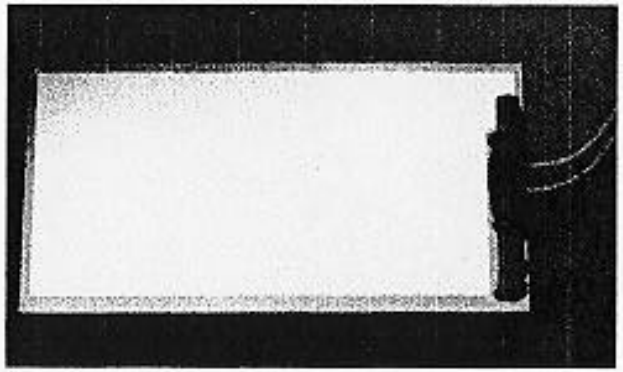
- ***Launched using standard STS hitchhiker ejection system in late 1998***



- ***Orbital Configuration***



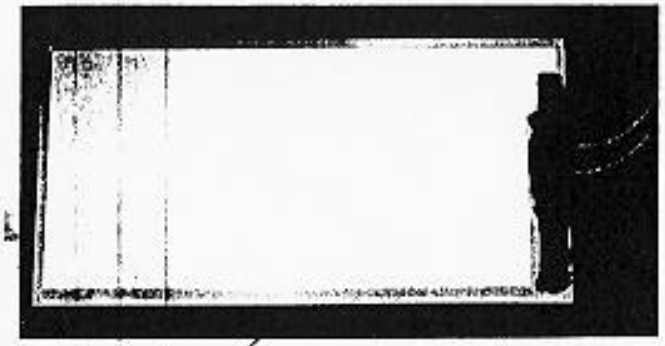
- ***Electronics***

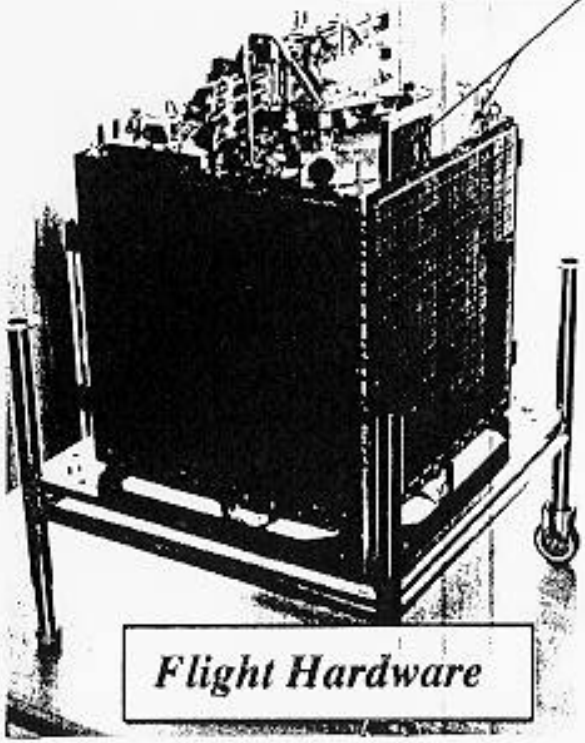


Two MOS type detectors furnished by LaRC are onboard.

SUNSAT M&D Experiment

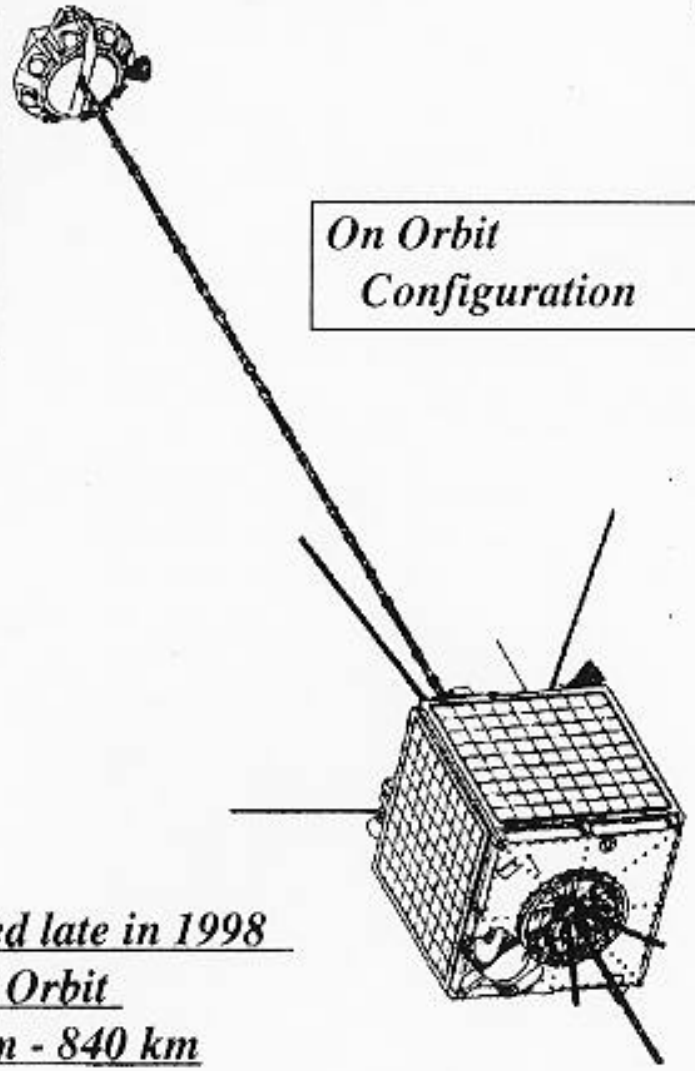
SUNSAT - South African Student Satellite





Flight Hardware

2 MOS Type Detectors furnished by LaRC are onboard.



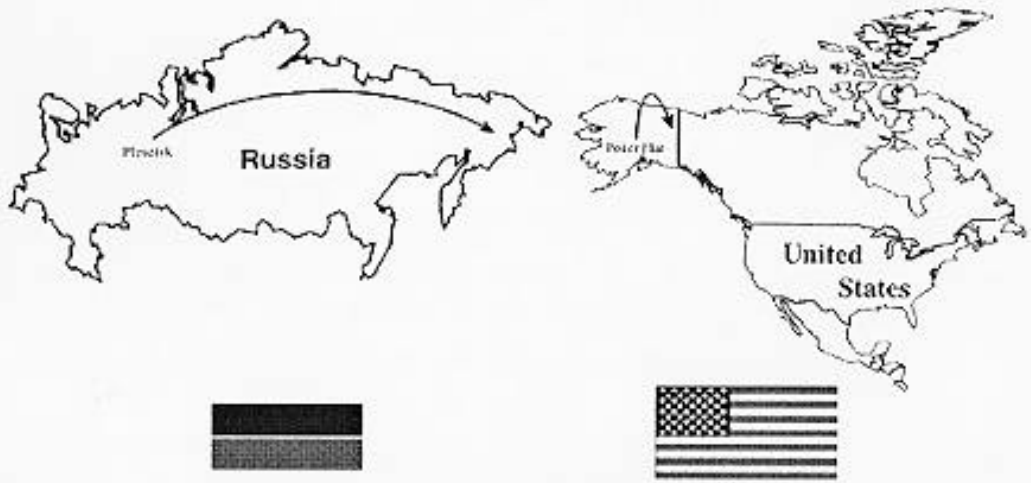
On Orbit Configuration

Launch expected late in 1998
Elliptical Polar Orbit
Altitude 400 km - 840 km

APEX Debris Experiment

ACTIVE PLASMA EXPERIMENT

APEX



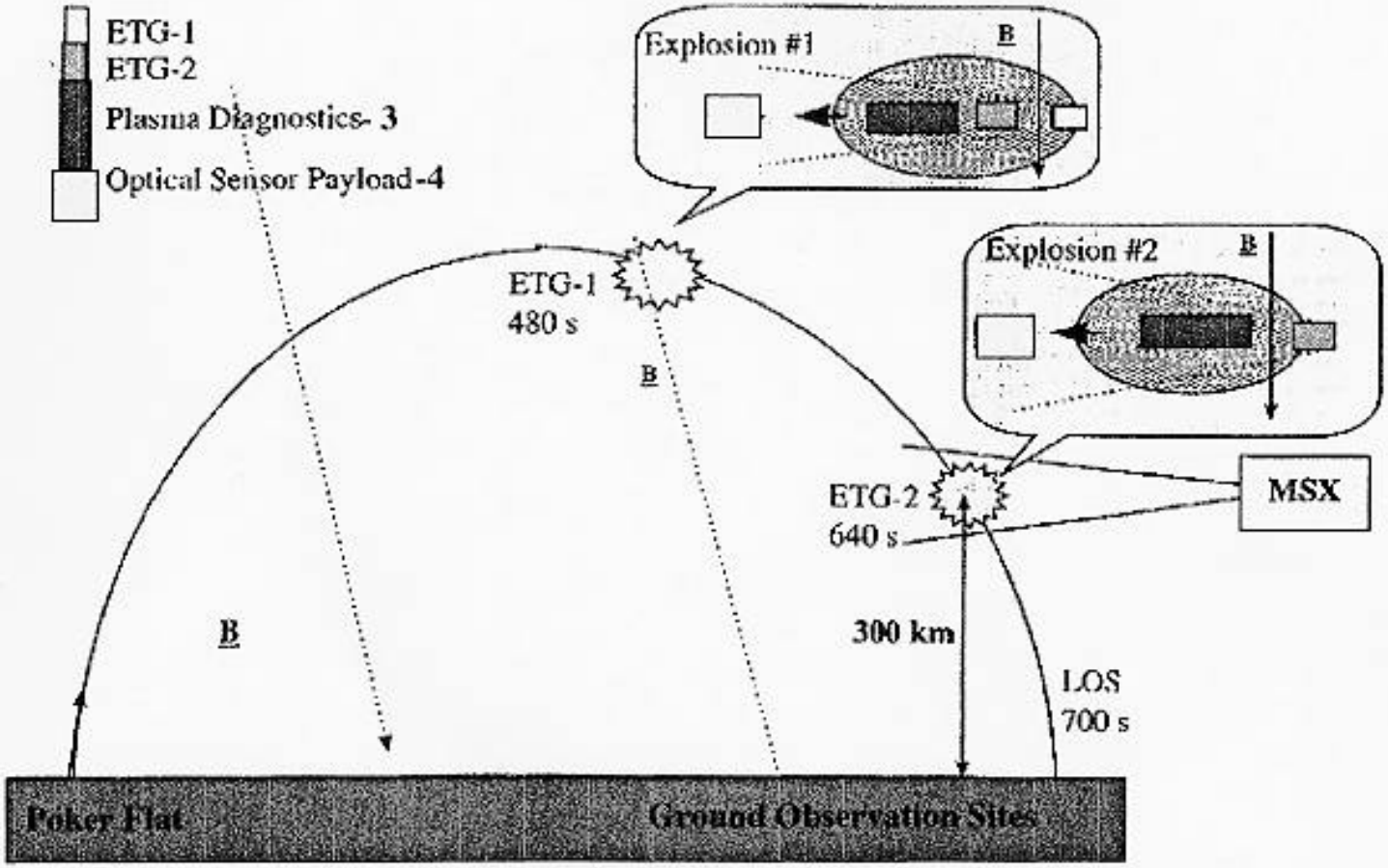
A Joint US/Russian Program

OBJECTIVE - *Characterize the physics related to the injection of an artificial plasma in the ionosphere.*

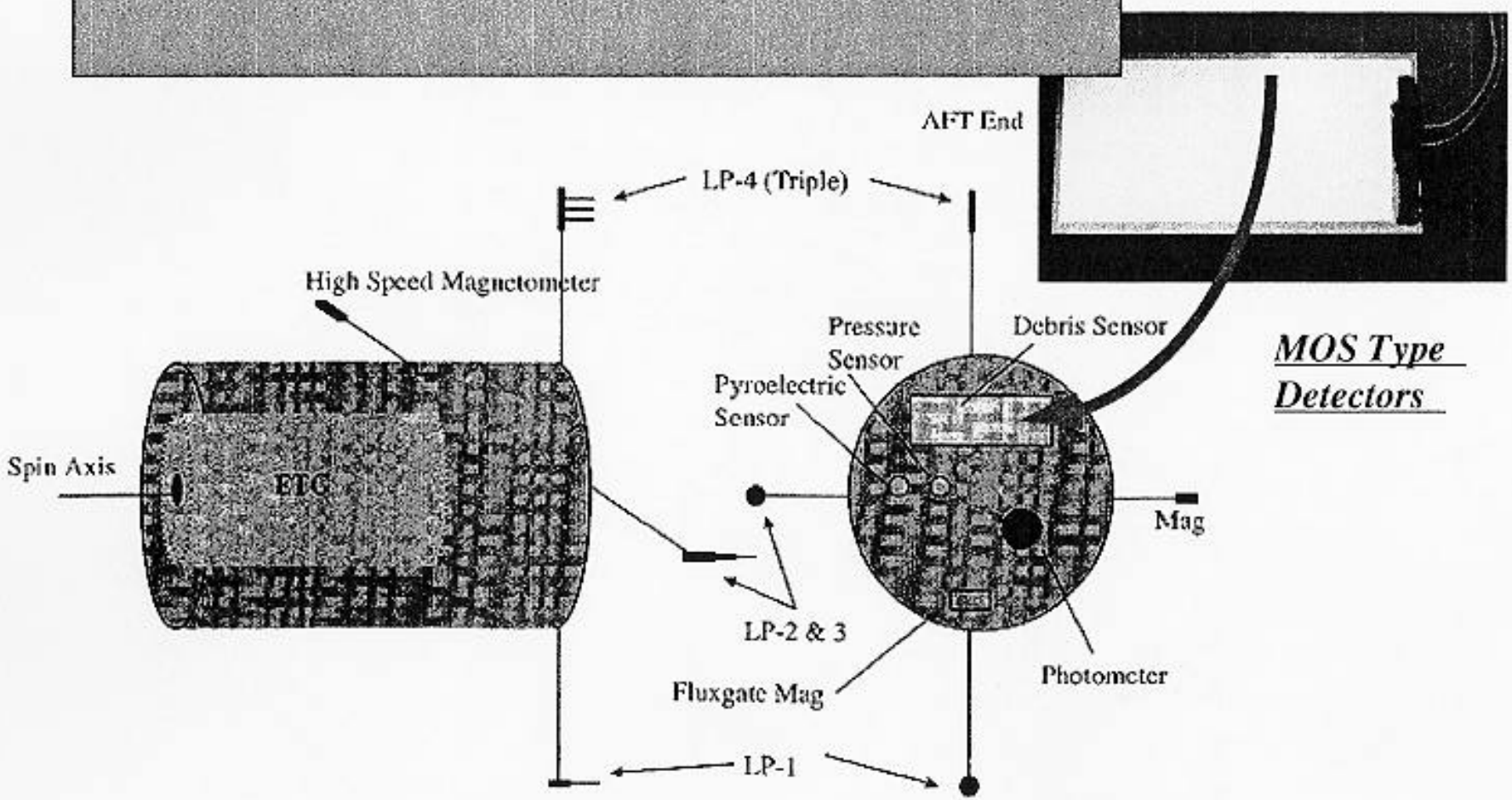
LaRC has provided particle impact detectors for the APEX

APEX Poker Flat Mission Concept

- ***4 spacecraft launched on single Black Brant XII launch vehicle .***

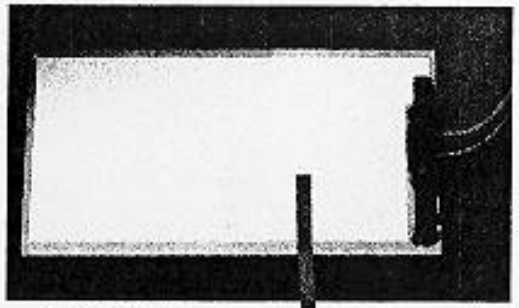


ETG-2 Spacecraft Instruments



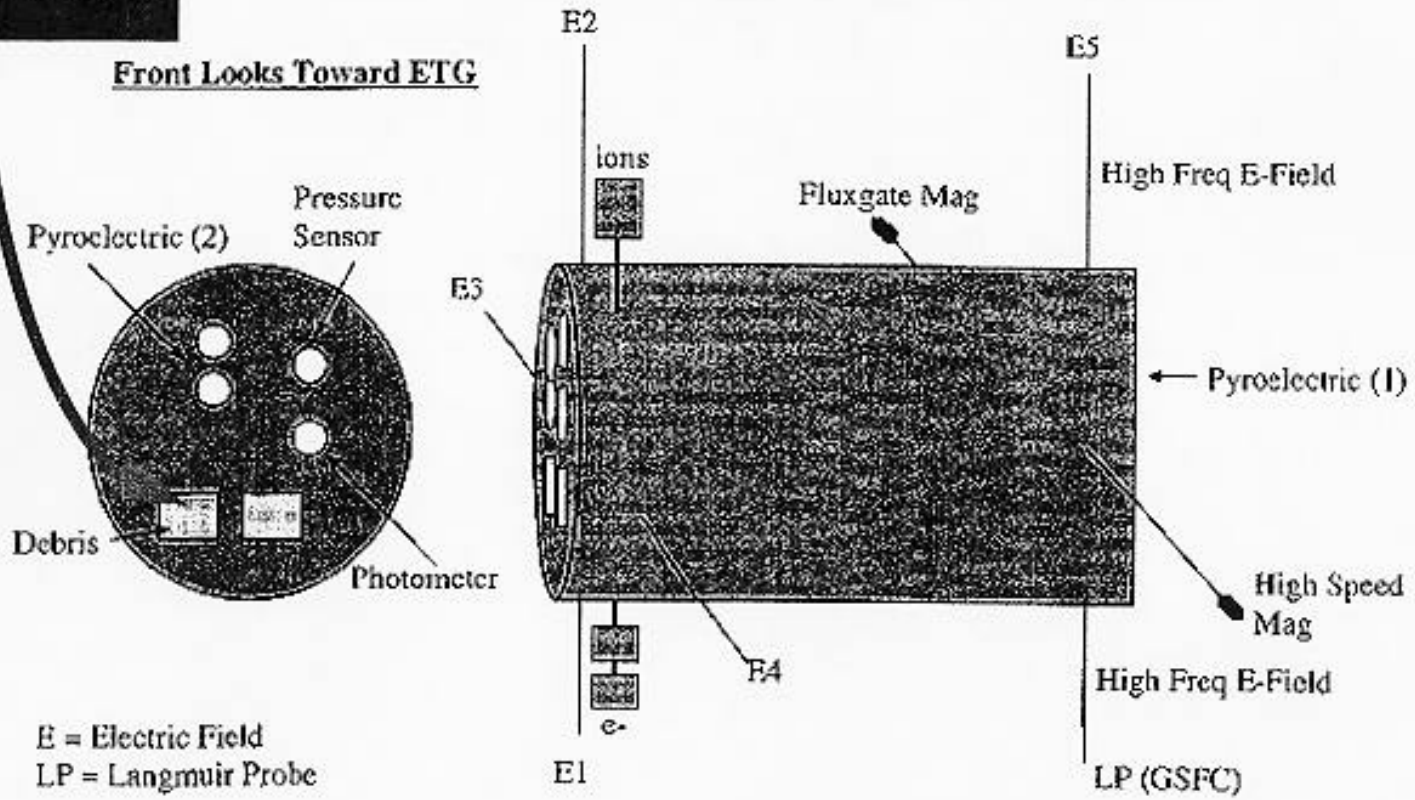
MOS Type Detectors

PDP Spacecraft Instruments



MOS Type Detectors

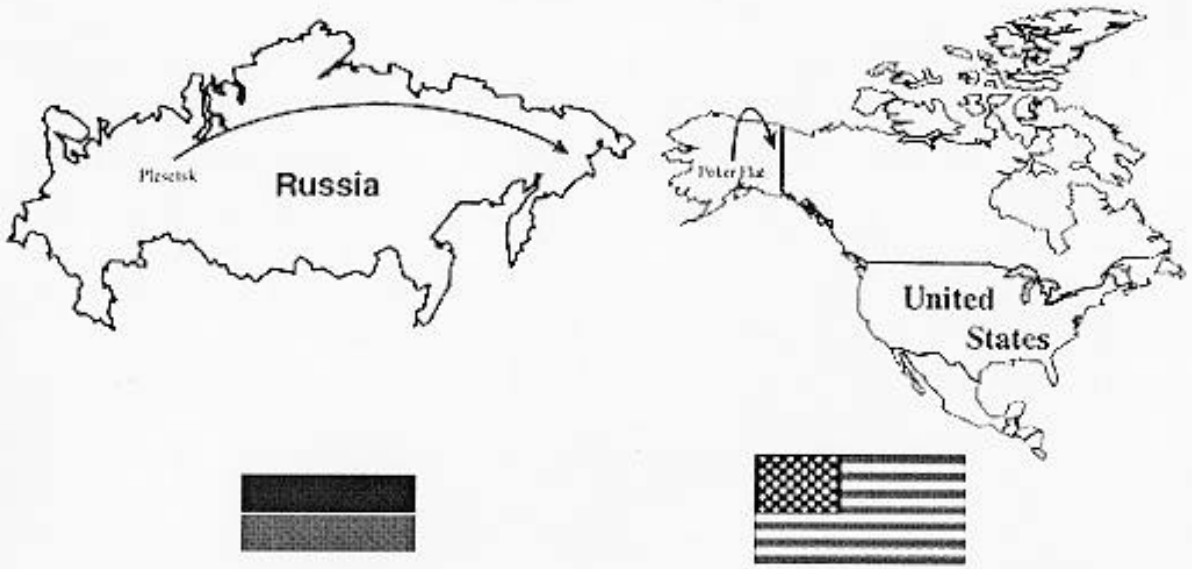
Front Looks Toward ETG



E = Electric Field
LP = Langmuir Probe

ACTIVE PLASMA EXPERIMENT

APEX



Expected Results From Debris Sensors → *Indication of the populations of micron size particles generated by in-space spacecraft explosions.*